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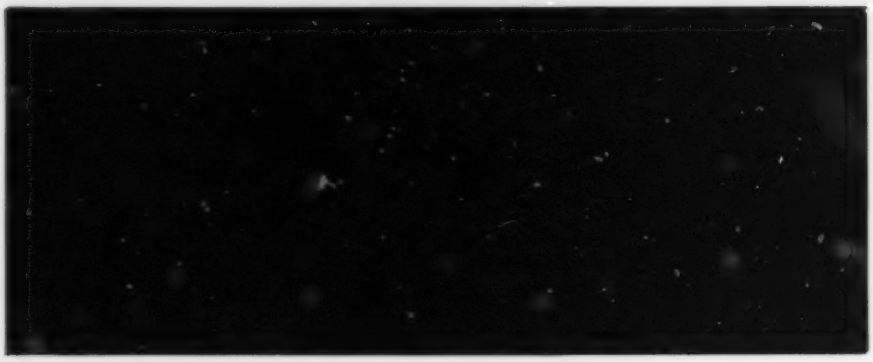

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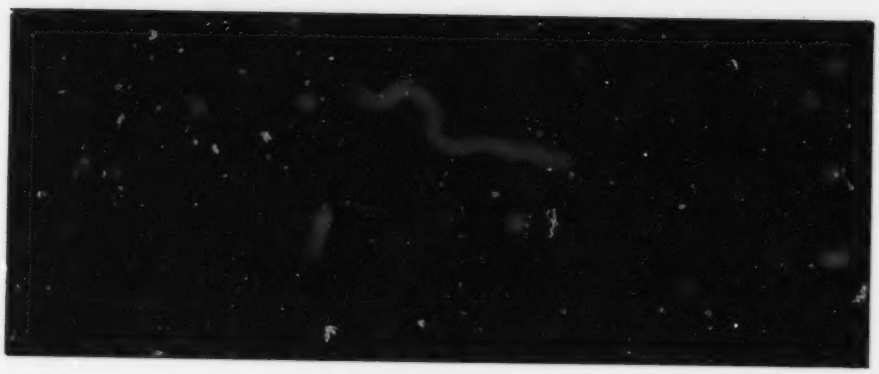

91-02629/

Technical/Final Report
to
Saskatchewan Agriculture Research Fund

# Testing a Vaccine for Viral Calf Scours

S-85-01-0016/5-85-29

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# FINAL REPORT
# SASKATCHEWAN AGRICULTURAL RESEARCH FUND
# PROJECT #5-85-29
# "Testing a Vaccine for Viral Calf Scours"

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Veterinary Infectious Disease Organization

## A. Executive Summary

a) Abstract - A new vaccine for viral calf scours has been developed by VIDO. Earlier studies indicated that significant increases in milk antibody levels were obtained when previously unvaccinated cows were immunized twice, 10 to 15 weeks apart with the second vaccination being given a few weeks before the onset of calving in a herd. The objective of this study was to determine if a single booster vaccination given at various times before calving in the second year of a herd vaccination protocol was sufficient to provide protective immunity. Cows which had been vaccinated twice the previous calving season were given a single booster vaccination at approximately 110, 70 or 30 days before the onset of calving. Milk antibody levels, which provide a measure of protection, were highest in the group given the booster vaccination at 30 days before calving. However, even in this group milk antibody levels were increased for only 5 days post-calving. Therefore, a single booster vaccination may not be sufficient to provide maximum protection against viral calf scours which occurs most frequently during the second and third weeks of life.

b) Summary - Calf scours continue to be one of the most important infectious diseases for cow-calf producers. Two of the most common causes of scours are rotavirus and coronavirus which cause severe diarrhea in two to three week old calves. VIDO has developed a new vaccine against these viruses. The vaccine is administered to pregnant cows and causes an increase in protective antibody levels which are transferred to the calf through the colostrum and milk during suckling.

Earlier studies showed that in previously unvaccinated cows, significant increases in milk antibody titers were obtained following two intramuscular injections 10 to 15 weeks apart, with the second injection being given a few weeks before calving. The objective of the current study was to determine the best vaccination protocol to use in the second and subsequent years of a vaccination program.

Cows which had been vaccinated twice during the previous calving season were given a single booster vaccination at approximately 110, 70, or 30 days before the onset of calving within the group. Milk antibody levels were measured at 1, 5, 10, and 20 days following calving. Milk antibody titers were highest in the group given the booster vaccination at 30 days before calving. However, even in this group increased antibody levels lasted only until 5 days post-calving. Therefore, a single booster vaccination may not be sufficient to provide maximum protection against viral calf scours which occurs most frequently during the second and third weeks of life. Additional studies are underway to further improve the vaccine so that two vaccinations are not required in each year.

B. Technical Report

a) Abstract - A new vaccine for the viral causes of calf scours has been developed by VIDO. Earlier studies indicated that significant increases in milk antibody levels were obtained when previously unvaccinated cows were immunized twice, 10 to 15 weeks apart with the second vaccination being given a few weeks before the onset of calving in a herd. The objective of this study was to determine if a single booster vaccination given at various times before calving in the second year of a herd vaccination protocol was sufficient to provide protective immunity. Cows which had been vaccinated twice the previous calving season were given a single booster vaccination at approximately 110, 70 or 30 days before the onset of calving. Milk antibody levels, which provide a measure of protection, were highest in the group given the booster vaccination at 30 days before calving. However, even in this group milk antibody levels were increased for only 5 days post-calving. Therefore, a single booster vaccination may not be sufficient to provide maximum protection against viral calf scours which occurs most frequently during the second and third weeks of life.

b) Background and Objectives

Calf scours continues to be one of the most important infectious diseases for cow-calf producers. Two of the most common causes of scours are rotaviruses and coronavirus. These viruses cause severe diarrhea in two to three-week old calves. Diagnostic tests performed on scouring calves submitted to the Western College of Veterinary Medicine indicate that between 30-50% of calves are infected with one or both of these viruses.

The only commercial vaccine available against these two viruses is produced by Norden Laboratories of Lincoln, Nebraska. Serological studies conducted at VIDO over the past three years indicate that this vaccine does not cause significant increases in antibody titers in the serum or milk of vaccinated cows. Reports from farmers and veterinarians also indicate that the vaccine does not appear to be effective under field conditions. In addition, it is a live vaccine and from time-to-time there has been contamination with bovine virus diarrhea virus which has resulted in abortions in vaccinated herds.

VIDO has developed a new vaccine against rota and coronavirus scours in newborn calves. The new vaccine contains two serotypes of rotavirus plus one serotype of coronavirus all of which are inactivated. The vaccine is administered to pregnant cows and causes an increase in serum antibody titers. Just prior to parturition, these antibodies are concentrated in the udder and are passed to the newborn calf after birth during suckling. It is the milk antibody which protects the intestinal tract of the newborn calves against infection with these viruses.

Previous trials conducted using the vaccine indicate that the immune response to both viruses was dose dependent. In previously unvaccinated cows, significant increases in milk antibody titers were obtained following two intramuscular injections 10 to 15 weeks apart, with the second injection being given a few weeks before calving. The objective of the current study was to determine the best vaccination protocol to use in the second and subsequent years of a vaccination program. Therefore, studies were undertaken to determine the effect on serum and milk antibody levels of a single booster vaccination, administered at various times before calving in cows vaccinated twice the previous year.

c) Experimental Methods

Vaccine preparations - Two serotypes of rotavirus are present in the vaccine; rotavirus strain 1 which is a member of subgroup 1, serotype 6, and rotavirus strain 2 which is a member of subgroup 1, serotype unknown. Both viruses were grown in tissue culture in activated with formalin and quantitated using an ELISA assay. A single strain of bovine coronavirus was also grown in tissue culture, inactivated and quantitated using a hemagglutination assay. Using the results from earlier studies as a basis, appropriate quantities of the three viruses were combined and then mixed with adjuvant. The final vaccine preparation was suspended into 100 ml serum bottles which were sealed with rubber stoppers and aluminum caps and stored at 4°C until used. A placebo was prepared with contained only growth medium, formalin and the adjuvant. This was used to inoculate control cows in the unvaccinated group.

A group of 62 crossbred cows which have been vaccinated with the experimental vaccine twice the preceding year were randomized into four experimental groups as shown in the following table.

| Group | Time of Booster Vaccination | Number of Animals |
|---|---|---|
| 1 | 110 BC[a] | 15 |
| 2 | 70 BC | 16 |
| 3 | 30 BC | 16 |
| 4 | Control | 15 |

[a] BC = days before calving.

Cows in Groups 1, 2, and 3 were given a single booster vaccination 110, 70, or 30 days before calving respectively. Cows in Group 4 received the placebo 110 before calving. Blood samples were collected from all cows at the three vaccination times and 22 days following the vaccination of Group 3 (approximately 8 days before the onset of calving in the group). A milk sample was collected from each cow at 1, 5, 10 and 20 days after calving. Neutralizing antibody titers to each of the three viruses was quantitated in blood serum and milk whey using virus neutralization assays.

d) Results and Discussion

A summary of the serological results for rotavirus strain 1, rotavirus strain 2, and coronavirus are shown in Tables 1, 2, and 3 respectively. Individual cow data for the same three viruses is shown in Tables 4 to 7 (Rotavirus Strain 1), 8 to 11 (Rotavirus Strain 2) and 12 to 15 (coronavirus).

A single vaccination significantly increased the blood antibody titers to all three viruses. However, the increase was transient and was detectable at 40 days (Groups 1, and 2) and 22 days (Group 3) after vaccination, but did not persist for 80 days after vaccination (Groups 1 and 2). The most noticeable increases in milk antibody titers occurred in Group 3 which was vaccinated approximately 30 days prior to the onset of calving. Generally, significant milk antibody titers were seen at 5 days after

parturition but did they not persist to any of the viruses until 10 days post-calving.

The results indicate, that of the three times selected for administration of the booster vaccine, the most significant increases in milk antibody titers occurred when the booster vaccination was administered about 30 days prior to the onset of calving (Group 3). Even in this group, milk antibody levels were not increased above the control group for longer than 5 days post-calving.

e) Conclusions and Impact

The results of this trial, conducted in only one herd, suggest that a single booster vaccination may not be sufficient to provide significant increases in milk antibody titers. During the previous year, when cows were immunized twice, with the second immunization being given a few weeks before the onset of calving, milk antibody titers were significantly increased for 10 to 20 days post-calving. In this trial, a single booster vaccination raised milk antibody levels for a maximum of five days post-calving since the peak occurrence of scours caused by these viruses occurs during the second and third weeks of life, this does not appear to be enough of an increase to protect calves during this high risk period. Additional studies will be required to investigate other potential vaccination protocols for previously vaccinated cows.

C. List of Papers Prepared in Talks Given

None to date.

D. Verified Statement of Expenditures

To follow - see covering letter.

E. List of Personnel Involved in the Project and the Percentage of Their Salaries Charged to the Project

To follow - see covering letter.

F. List of All Equipment Items in Excess of $500

To follow - see covering letter.

**Table 1**

**NEUTRALIZING ANTIBODY TITERS**

**Rotavirus Strain 1**

| | Serum[a] | | | | Milk Whey[b] | | | |
|---|---|---|---|---|---|---|---|---|
| Group | 110 | 70 | 30 | 8 | 1 | 5 | 10 | 20 |
| 1 | 1,076 | 28,245 | 5,513 | 4,522 | 22,051 | 181 | 34 | 14 |
| 2 | 1,218 | 1,512 | 8,933 | 5,087 | 18,658 | 128 | 52 | 17 |
| 3 | 1,218 | 1,512 | 1,069 | 16,384 | 31,288 | 406 | 67 | 29 |
| 4 | 1,123 | 1,482 | 1,123 | 1,351 | 9,504 | 82 | 31 | 10 |

[a] Serum titers on days before calving

[b] Milk titers on days after calving

**Table 2**

**NEUTRALIZING ANTIBODY TITERS**

**Rotavirus Strain 2**

| | Serum[a] | | | Milk Whey[b] | | | | |
|---|---|---|---|---|---|---|---|---|
| Group | 110 | 70 | 30 | 8 | 1 | 5 | 10 | 20 |
| 1 | 1,680 | 39,945 | 8,608 | 7,420 | 25,582 | 269 | 74 | 21 |
| 2 | 2,332 | 2,543 | 8,933 | 6,049 | 26,386 | 189 | 61 | 20 |
| 3 | 3,025 | 2,896 | 2,435 | 23,170 | 41,285 | 467 | 77 | 37 |
| 4 | 2,830 | 3,251 | 2,246 | 3,566 | 19,972 | 200 | 67 | 21 |

[a] Serum titers on days before calving

[b] Milk titers on days after calving

**Table 3**

**NEUTRALIZING ANTIBODY TITERS**

**Coronavirus**

| | Serum[a] | | | Milk Whey[b] | | | | |
|---|---|---|---|---|---|---|---|---|
| Group | 110 | 70 | 30 | 8 | 1 | 5 | 10 | 20 |
| 1 | 2,756 | 32,768 | 6,396 | 5,513 | 29,679 | 210 | 58 | 17 |
| 2 | 2,896 | 4,530 | 21,247 | 12,098 | 28,774 | 267 | 91 | 28 |
| 3 | 3,756 | 3,756 | 2,436 | 16,384 | 35,941 | 489 | 74 | 29 |
| 4 | 2,964 | 3,104 | 2,246 | 2,464 | 13,440 | 149 | 67 | 19 |

[a] Serum titers on days before calving

[b] Milk titers on days after calving

Table 4. Group 1 - Neutralizing Antibody Titers - Rotavirus Strain 1 - Individual Cow Data

KINSELLA TRIVALENT VACCINE TRIAL 1985-86

GROUP 1 Neutralizing Titres ROTAVIRUS C486

| | | ← serum → | | | | ← whey | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Cow # | 18/2 | 21/1 | 4/3 | 26/3 | 1d | 5d | 10d | 20d |
| 101 | 111-3 | 4096 | 65536 | 4096 | 4096 | 65536 | 256 | 64 | 16 |
| 101 | 903-3 | 2048 | 65536 | 16384 | 16384 | 16384 | 256 | 64 | 16 |
| 104 | 451-3 | 512 | 65536 | 16384 | 4096 | 2048 | 256 | 32 | 16 |
| 106 | 770-3 | 1024 | 4096 | 4096 | 1024 | 8192 | 32 | 16 | 4 |
| 107 | 774-1 | 1024 | 65536 | 4096 | 4096 | 65536 | 64 | 64 | 32 |
| 108 | 11-2 | 1024 | 16384 | 1024 | 2048 | 16384 | 1024 | 16 | 16 |
| 109 | 807-3 | 1024 | 65536 | 8192 | 4096 | 16384 | 256 | 16 | 4 |
| 110 | 702-0 | 1024 | 65536 | 4096 | 4096 | 16384 | 1024 | 64 | 64 |
| 114 | 445-3 | 4096 | 65536 | 16384 | 16384 | 65536 | 256 | 16 | 4 |
| 120 | 754-1 | 512 | 16384 | 4096 | 4096 | 65536 | 64 | 64 | 16 |
| 127 | 308-3 | 1024 | 16384 | 8192 | 16384 | 16384 | 256 | 64 | 16 |
| 130 | 213-3 | 1024 | 32768 | 4096 | 4096 | 65536 | 256 | 64 | 64 |
| 133 | 12-3 | 256 | 65536 | 16384 | 8192 | 16384 | 64 | 16 | 16 |
| 147 | 426-3 | 1024 | 1024 | 1024 | 1024 | 16384 | 64 | 16 | |
| GMT | | 1076 | 28245 | 5513 | 4522 | 22051 | 181 | 34 | 14 |
| L | | 256 | 1024 | 1024 | 1024 | 2048 | 32 | 16 | 4 |
| H | | 4096 | 65536 | 16384 | 16384 | 65536 | 1024 | 64 | 64 |
| n. | | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 13 |

Table 5. Group 2 - Neutralizing Antibody Titers - Rotavirus Strain 1 - Individual Cow Data

KINSELLA TRIVALENT VACCINE TRIAL 1985-86

GROUP 2 Neutralizing Titres ROTAVIRUS C486

| | | ← serum → | | | | ← whey → | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Cow # | 18/2 | 21/1 | 4/3 | 26/3 | 1d | 5d | 10d | 20d |
| 96 | 905-3 | 4096 | 4096 | 16384 | 4096 | 65536 | 64 | 64 | 256 |
| 99 | 446-3 | 1024 | 1024 | 16384 | 16384 | 16384 | 16 | 64 | 16 |
| 100 | 750-2 | 1024 | 1024 | 16384 | 16384 | 4096 | 64 | 64 | 4 |
| 100 | 843-3 | 1024 | 1024 | 8192 | 4096 | 4096 | 32 | 16 | 8 |
| 106 | 245-3 | 1024 | 1024 | 8192 | 4096 | 256 | 64 | 16 | 4 |
| 106 | 760-9 | 4096 | 4096 | 16384 | 4096 | 65536 | 4096 | 64 | 16 |
| 106 | 774-3 | 512 | 1024 | 16384 | 4096 | 65536 | 32 | 16 | 4 |
| 107 | 208-8 | 1024 | 1024 | 1024 | 1024 | 16384 | 256 | 16 | 4 |
| 107 | 557-3 | 256 | 256 | 1024 | 1024 | 16384 | 256 | 16 | 16 |
| 108 | 459-3 | 1024 | 2048 | 16384 | 8192 | 65536 | 64 | 16 | 16 |
| 110 | 26-3 | 1024 | 1024 | 4096 | 4096 | 16384 | 64 | 64 | 16 |
| 115 | 377-8 | 4096 | 16384 | 65536 | 16384 | 65536 | 256 | 128 | 64 |
| 118 | 427-3 | 256 | 256 | 1024 | 1024 | 4096 | 16 | 16 | 4 |
| 121 | 378-3 | 1024 | 1024 | 16384 | 16384 | 65536 | 1024 | 1024 | 64 |
| 122 | 16-8 | 2048 | 4096 | 16384 | 4096 | 32768 | 64 | 512 | 64 |
| 122 | 240-0 | 4096 | 4096 | 16384 | 16384 | 65536 | 4096 | 128 | 64 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| GMT | | 1218 | 1512 | 8933 | 5087 | 18658 | 128 | 52 | 17 |
| L | | 256 | 256 | 1024 | 1024 | 256 | 16 | 16 | 4 |
| H | | 4096 | 16384 | 65536 | 16384 | 65536 | 4096 | 1024 | 256 |
| n. | | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |

**Table 6. Group 3 - Neutralizing Antibody Titers - Rotavirus Strain 1 - Individual Cow Data**

RINGELLA TRIVALENT VACCINE TRIAL 1985-86

GROUP 3 Neutralizing Titres ROTAVIRUS C486

| | | ← serum → | | | | ← whey → | | | |
|---|---|---|---|---|---|---|---|---|---|
| Pen | Date | Cow # | 18/2 | 21/1 | 4/3 | 26/3 | 1d | 5d | 10d | 20d |
| 97 | | 915-3 | 1024 | 1024 | 1024 | 8192 | 65536 | 65536 | 256 | 256 |
| 103 | | 466-3 | 4096 | 4096 | 1024 | 65536 | 65536 | 2048 | 64 | 16 |
| 108 | | 751-9 | 1024 | 4096 | 4096 | 65536 | 65536 | 4096 | 64 | 64 |
| 109 | | 111-9 | 4096 | 1024 | 4096 | 8192 | 65536 | 64 | 64 | 16 |
| 109 | | 584-3 | 1024 | 1024 | 1024 | 4096 | 16384 | 256 | 64 | 64 |
| 113 | | 786-3 | 1024 | 1024 | 1024 | 8192 | 65536 | 64 | 16 | 16 |
| 115 | | 10-2 | 1024 | 1024 | 1024 | 65536 | 65536 | 4096 | 256 | 64 |
| 115 | | 281-3 | 4096 | 4096 | 1024 | 65536 | 65536 | 1024 | 256 | 256 |
| 115 | | 403-3 | 1024 | 1024 | 512 | 16384 | 16384 | 64 | 16 | 4 |
| 117 | | 428-3 | 512 | 1024 | 256 | 4096 | 4096 | 2048 | 256 | 16 |
| 118 | | 278-3 | 128 | 256 | 64 | 128 | 1024 | 4 | ≤4 | ≤4 |
| 120 | | 852-3 | 256 | 512 | 256 | 16384 | 16384 | 64 | 16 | 16 |
| 130 | | 779-0 | 4096 | 16384 | 16384 | 65536 | 65536 | 256 | 256 | 64 |
| 137 | | 447-3 | 4096 | 4096 | 4096 | 65536 | 65536 | 256 | 64 | 32 |
| 145 | | 40-3 | 1024 | 1024 | 1024 | 65536 | 65536 | 256 | 256 | / |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| — | | 380-1 | 1024 | 1024 | 1024 | 16384 | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| GMT | | | 1218 | 1512 | 1069 | 16384 | 31288 | 406 | 67 | 29 |
| L | | | 128 | 256 | 64 | 128 | 1024 | 4 | ≤4 | ≤4 |
| H | | | 4096 | 16384 | 16384 | 65536 | 65536 | 65536 | 256 | 256 |
| n. | | | 16 | 16 | 16 | 16 | 15 | 15 | 15 | 14 |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

Table 7. Group 4 - Neutralizing Antibody Titers - Rotavirus Strain 1 - Individual Cow Data

KINSELLA TRIVALENT VACCINE TRIAL 1985-36

GROUP 4 Neutralizing Titres ROTAVIRUS C486

| | | ← serum → | | | | ← whey → | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Cow # | 18/2 | 21/1 | 4/3 | 26/3 | 1d | 5d | 10d | 20d |
| 98 | 804-3 | 1024 | 1024 | 1024 | 1024 | 4096 | 256 | 4096 | 64 |
| 100 | 437-3 | 1024 | 1024 | 1024 | 1024 | 4096 | 64 | 8 | 16 |
| 104 | 415-3 | 1024 | 256 | 512 | 512 | 16384 | 16 | 4 | 4 |
| 109 | 768-3 | 256 | 256 | 256 | 256 | 16384 | 16 | 4 | 16 |
| 113 | 701-1 | 1024 | 1024 | 1024 | 1024 | 4096 | 64 | 4 | 4 |
| 114 | 902-3 | 4096 | 4096 | 4096 | 4096 | 65536 | 64 | 16 | 4 |
| 115 | 298-3 | 4096 | 4096 | 4096 | 4096 | 16384 | 128 | 64 | 16 |
| 116 | 101-3 | 1024 | 32768 | 2048 | 2048 | 16384 | 64 | 16 | 16 |
| 118 | 448-3 | 4096 | 4096 | 4096 | 4096 | 2048 | 16 | 16 | 4 |
| 124 | 7-9 | 256 | 256 | 256 | 256 | 4096 | 16 | 16 | 4 |
| 125 | 1-1 | 1024 | 4096 | 4096 | 4096 | 4096 | 256 | 64 | 64 |
| 126 | 3-3 | 1024 | 1024 | 1024 | 1024 | 16384 | 16 | 16 | 4 |
| 146 | 770-7 | 256 | 256 | 1024 | 1024 | 4096 | 1024 | 64 | |
| 147 | 469-3 | 4096 | 4096 | 1024 | 4096 | 65536 | 4096 | 1024 | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| - | 235-8 | 1024 | 2048 | 256 | 1024 | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| GMT | | 1123 | 1482 | 1123 | 1351 | 9504 | 82 | 31 | 10 |
| L | | 256 | 256 | 256 | 256 | 2048 | 16 | 4 | 4 |
| H | | 4096 | 32768 | 4096 | 4096 | 65536 | 4096 | 4096 | 64 |
| n. | | 15 | 15 | 15 | 15 | 14 | 14 | 14 | 12 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

**Table 8. Group 1 - Neutralizing Antibody Titers - Rotavirus Strain 2 - Individual Cow Data**

KINDELLA TRIVALENT VACCINE TRIAL 1985-86

GROUP 1 Neutralizing Titres ROTAVIRUS 2352

| Date | Cow # | serum 18/2 | serum 21/1 | serum 4/3 | serum 26/3 | whey 1d | whey 5d | whey 10d | whey 20d |
|---|---|---|---|---|---|---|---|---|---|
| 101 | 111-3 | 4096 | 65536 | 4096 | 16384 | 65536 | 256 | 64 | 64 |
| 101 | 903-3 | 4096 | 65536 | 16384 | 16384 | 65536 | 256 | 256 | 64 |
| 104 | 451-3 | 1024 | 65536 | 8192 | 4096 | 4096 | 256 | 64 | 16 |
| 106 | 770-3 | 1024 | 65536 | 16384 | 16384 | 65536 | 512 | 64 | 16 |
| 107 | 774-1 | 256 | 8192 | 1024 | 512 | 16384 | 64 | 64 | 4 |
| 108 | 11-2 | 1024 | 16384 | 512 | 512 | 4096 | 256 | 16 | 4 |
| 109 | 807-3 | 512 | 65536 | 4096 | 4096 | 4096 | 256 | 16 | 4 |
| 110 | 702-0 | 4096 | 65536 | 65536 | 65536 | 65536 | 4096 | 1024 | 256 |
| 114 | 445-3 | 32768 | 131072 | 65536 | 65536 | 262144 | 1024 | 256 | 16 |
| 120 | 754-1 | 1024 | 65536 | 8192 | 4096 | 65536 | 64 | 64 | 16 |
| 127 | 308-3 | 16384 | 65536 | 65536 | 16384 | 32768 | 1024 | 128 | 32 |
| 130 | 213-3 | 1024 | 65536 | 4096 | 4096 | 65536 | 256 | 64 | 64 |
| 133 | 12-3 | 512 | 65536 | 65536 | 65536 | 16384 | 64 | 64 | 16 |
| 147 | 426-3 | 512 | 1024 | 1024 | 1024 | 4096 | 64 | 16 | / |
| GMT | | 1680 | 39,945 | 8608 | 7420 | 25,582 | 269 | 74 | 21 |
| L | | 256 | 1024 | 512 | 512 | 4096 | 64 | 16 | 4 |
| H | | 32,768 | 131,072 | 65,536 | 65,536 | 262,144 | 4096 | 1024 | 256 |
| no. | | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 13 |

**Table 9. Group 2 - Neutralizing Antibody Titers - Rotavirus Strain 2 - Individual Cow Data**

KINDELLA TRIVALENT VACCINE TRIAL 1985-36

GROUP 2 Neutralizing Titres ROTAVIRUS 2352

| | | ← serum → | | | | ← whey → | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Cow # | 18/2 | 21/1 | 4/3 | 26/3 | 1d | 5d | 10d | 20d |
| 96 | 905-3 | 4096 | 4096 | 8192 | 4096 | 65536 | 256 | 64 | 64 |
| 99 | 446-3 | 4096 | 4096 | 65536 | 65536 | 65536 | 64 | 64 | 64 |
| 100 | 750-2 | 1024 | 1024 | 4096 | 1024 | 1024 | 64 | 64 | 2 |
| 100 | 843-3 | 1024 | 1024 | 4096 | 4096 | 4096 | 64 | 16 | 16 |
| 106 | 245-3 | 1024 | 1024 | 4096 | 4096 | 1024 | 64 | 16 | 4 |
| 106 | 760-9 | 4096 | 4096 | 16384 | 4096 | 65536 | 4096 | 64 | 16 |
| 106 | 774-3 | 4096 | 2048 | 4096 | 16384 | 65536 | 64 | 32 | 4 |
| 107 | 208-8 | 4096 | 4096 | 4096 | 4096 | 16384 | 256 | 16 | 16 |
| 107 | 557-3 | 1024 | 1024 | 1024 | 1024 | 16384 | 256 | 16 | 16 |
| 108 | 459-3 | 8192 | 16384 | 65536 | 32768 | 65536 | 128 | 64 | 16 |
| 110 | 26-3 | 1024 | 1024 | 4096 | 2048 | 32768 | 64 | 64 | 16 |
| 115 | 377-8 | 16384 | 16384 | 65536 | 65536 | 262144 | 256 | 256 | 256 |
| 118 | 427-3 | 1024 | 1024 | 4096 | 2048 | 65536 | 64 | 32 | 4 |
| 121 | 378-3 | 1024 | 1024 | 16384 | 4096 | 65536 | 1024 | 256 | 64 |
| 122 | 16-8 | 1024 | 4096 | 4096 | 4096 | 16384 | 64 | 1024 | 64 |
| 122 | 240-0 | 4096 | 4096 | 32768 | 16384 | 65536 | 4096 | 128 | 64 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| GMT | | 2332 | 2543 | 8933 | 6049 | 26386 | 189 | 61 | 20 |
| L | | 1024 | 1024 | 1024 | 1024 | 1024 | 64 | 16 | 2 |
| H | | 16384 | 16384 | 65536 | 65536 | 262144 | 4096 | 1024 | 256 |
| no. | | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

**Table 10. Group 3 - Neutralizing Antibody Titers - Rotavirus Strain 2 - Individual Cow Data**

KINDELLA TRIVALENT VACCINE TRIAL 1980-86

GROUP 3 Neutralizing Titres ROTAVIRUS 2352

| | | ← Serum → | | | | ← whey → | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Cow # | 18/2 | 21/1 | 4/3 | 26/3 | 1d | 5d | 10d | 20d |
| 97 | 915-3 | 4096 | 4096 | 4096 | 65536 | 65536 | 65536 | 256 | 256 |
| 103 | 466-3 | 16384 | 16384 | 4096 | 65536 | 131072 | 4096 | 64 | 64 |
| 108 | 751-9 | 4096 | 4096 | 4096 | 65536 | 65536 | 4096 | 16 | 64 |
| 109 | 111-9 | 4096 | 2048 | 4096 | 8192 | 65536 | 256 | 64 | 64 |
| 109 | 584-3 | 1024 | 1024 | 1024 | 1024 | 16384 | 64 | 64 | 64 |
| 113 | 786-3 | 4096 | 4096 | 4096 | 16384 | 65536 | 64 | 16 | 16 |
| 115 | 10-2 | 1024 | 1024 | 1024 | 65536 | 16384 | 1024 | 128 | 64 |
| 115 | 281-3 | 16384 | 4096 | 4096 | 65536 | 131072 | 2048 | 1024 | 256 |
| 115 | 403-3 | 4096 | 8192 | 4096 | 65536 | 65536 | 256 | 64 | 16 |
| 117 | 428-3 | 1024 | 1024 | 512 | 16384 | 16384 | 4096 | 1024 | 16 |
| 118 | 278-3 | 256 | 256 | 256 | 256 | 1024 | 4 | 4 | ≤4 |
| 120 | 852-3 | 1024 | 1024 | 1024 | 32768 | 16384 | 64 | 16 | 16 |
| 130 | 779-0 | 8192 | 16384 | 8192 | 65536 | 65536 | 256 | 256 | 64 |
| 137 | 447-3 | 4096 | 4096 | 4096 | 16384 | 65536 | 256 | 64 | 16 |
| 145 | 40-3 | 4096 | 4096 | 4096 | 262144 | 262144 | 256 | 128 | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| — | 380-1 | 4096 | 4096 | 4096 | 16384 | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | GMT | 3025 | 2896 | 2435 | 23170 | 41285 | 467 | 77 | 37 |
| | L | 256 | 256 | 256 | 256 | 1024 | 4 | 4 | 2 |
| | H | 16384 | 16384 | 8192 | 262144 | 262144 | 65536 | 1024 | 256 |
| | n. | 16 | 16 | 16 | 16 | 15 | 15 | 15 | 14 |
| | | | | | | | | | |
| | | | | | | | | | |

**Table 11. Group 4 - Neutralizing Antibody Titers - Rotavirus Strain 2 - Individual Cow Da**

KINDELLA INTRANASAL VACCINE TRIAL 1985-86

GROUP 4 Neutralizing Titres ROTAVIRUS 2352

| | | ← Serum → | | | | ← whey → | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Cow # | 18/2 | 21/1 | 4/3 | 26/3 | 1d | 5d | 10d | 20 |
| 98 | 804-3 | 1024 | 4096 | 1024 | 1024 | 4096 | 256 | 4096 | 64 |
| 100 | 437-3 | 4096 | 4096 | 4096 | 4096 | 8192 | 64 | 16 | 32 |
| 104 | 415-3 | 1024 | 1024 | 1024 | 1024 | 65536 | 64 | 16 | 4 |
| 109 | 768-3 | 2048 | 2048 | 1024 | 2048 | 65536 | 64 | 16 | 64 |
| 113 | 701-1 | 8192 | 8192 | 4096 | 65536 | 16384 | 128 | 16 | 16 |
| 114 | 902-3 | 4096 | 8192 | 4096 | 4096 | 65536 | 256 | 64 | 16 |
| 115 | 298-3 | 4096 | 4096 | 4096 | 4096 | 16384 | 256 | 32 | 16 |
| 116 | 101-3 | 4096 | 65536 | 4096 | 16384 | 65536 | 1024 | 64 | 64 |
| 118 | 448-3 | 65536 | 16384 | 65536 | 65536 | 4096 | 64 | 64 | 16 |
| 124 | 7-9 | 1024 | 1024 | 1024 | 1024 | 8192 | 64 | 64 | 4 |
| 125 | 1-1 | 1024 | 1024 | 4096 | 4096 | 4096 | 256 | 64 | 64 |
| 126 | 3-3 | 4096 | 4096 | 4096 | 4096 | 65536 | 64 | 16 | 16 |
| 146 | 770-7 | 4096 | 512 | 1024 | 1024 | 16384 | 1024 | 256 | |
| 147 | 469-3 | 1024 | 2048 | 512 | 1024 | 65536 | 4096 | 1024 | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| – | 235-8 | 1024 | 1024 | 256 | 1024 | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| GMT | | 2830 | 3251 | 2246 | 3566 | 19972 | 200 | 67 | 21 |
| L | | 1024 | 512 | 512 | 1024 | 4096 | 64 | 16 | 4 |
| H | | 65536 | 65536 | 65536 | 65536 | 65536 | 4096 | 1024 | 64 |
| n | | 15 | 15 | 15 | 15 | 14 | 14 | 14 | 12 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

**Table 12. Group 1 - Neutralizing Antibody Titers - Coronavirus - Individual Cow Data**

KINSELLA TRIVALENT VACCINE TRIAL 1985-86

GROUP 1 Neutralizing Titres CORONAVIRUS

| | | ← Serum → | | | | ← Whey → | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Cow # | 18/2 | 21/1 | 4/3 | 26/3 | 1d | 5d | 10d | 20d |
| 101 | 111-3 | 4096 | 65536 | 4096 | 16384 | 65536 | 256 | 64 | 16 |
| 101 | 903-3 | 8192 | 65536 | 32768 | 16384 | 65536 | 256 | 256 | 64 |
| 104 | 451-3 | 4096 | 16384 | 4096 | 4096 | 1024 | 64 | 8 | ≤4 |
| 106 | 770-3 | 256 | 16384 | 2048 | 1024 | 4096 | 64 | 64 | 16 |
| 107 | 774-1 | 1024 | 4096 | 1024 | 1024 | 65536 | 64 | 64 | 16 |
| 108 | 11-2 | 2048 | 65536 | 4096 | 4096 | 65536 | 4096 | 64 | 16 |
| 109 | 807-3 | 8192 | 16384 | 4096 | 4096 | 16384 | 512 | 16 | 4 |
| 110 | 702-0 | 4096 | 65536 | 16384 | 8192 | 65536 | 1024 | 64 | 64 |
| 114 | 445-3 | 8192 | 65536 | 32768 | 16384 | 65536 | 256 | 64 | 8 |
| 120 | 754-1 | 1024 | 65536 | 4096 | 2048 | 65536 | 64 | 64 | 16 |
| 127 | 308-3 | 4096 | 32768 | 16384 | 32768 | 16384 | 256 | 64 | 32 |
| 130 | 213-3 | 1024 | 65536 | 4096 | 4096 | 32768 | 64 | 64 | 32 |
| 133 | 12-3 | 4096 | 65536 | 8192 | 8192 | 32768 | 128 | 128 | 32 |
| 147 | 426-3 | 4096 | 8192 | 4096 | 4096 | 65536 | 256 | 64 | / |
| GMT | | 2756 | 32768 | 6396 | 5513 | 29679 | 210 | 58 | 17 |
| L | | 256 | 4096 | 2048 | 1024 | 1024 | 64 | 8 | ≤4 |
| H | | 8192 | 65536 | 32768 | 32768 | 65536 | 4096 | 256 | 64 |
| n. | | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 13 |

**Table 13. Group 2 - Neutralizing Antibody Titers - Coronavirus - Individual Cow Data**

KINSELLA TRIVALENT VACCINE TRIAL 1985-86

GROUP 2 Neutralizing Titres CORONAVIRUS

| | | ← serum → | | | | ← whey → | | | |
|---|---|---|---|---|---|---|---|---|---|
| ½ Date | Cow # | 18/2 | 21/1 | 4/3 | 26/3 | 1d | 5d | 10d | 20d |
| 96 | 905-3 | 4096 | 16384 | 65536 | 65536 | 65536 | 64 | 64 | 64 |
| 99 | 446-3 | 4096 | 4096 | 32768 | 65536 | 32768 | 64 | 64 | 64 |
| 100 | 750-2 | 1024 | 1024 | 16384 | 4096 | 4096 | 256 | 256 | 4 |
| 100 | 843-3 | 1024 | 1024 | 32768 | 8192 | 16384 | 256 | 64 | 64 |
| 106 | 245-3 | 1024 | 4096 | 8192 | 4096 | 1024 | 64 | 16 | 4 |
| 106 | 760-9 | 1024 | 2048 | 16384 | 4096 | 65536 | 4096 | 128 | 16 |
| 106 | 774-3 | 2048 | 4096 | 32768 | 16384 | 32768 | 128 | 32 | 4 |
| 107 | 208-8 | 4096 | 16384 | 65536 | 16384 | 65536 | 1024 | 64 | 32 |
| 107 | 551-3 | 1024 | 1024 | 1024 | 1024 | 16384 | 256 | 32 | 16 |
| 108 | 459-3 | 2048 | 2048 | 16384 | 4096 | 16384 | 64 | 16 | 16 |
| 110 | 26-3 | 4096 | 4096 | 16384 | 16384 | 32768 | 64 | 64 | 16 |
| 115 | 377-8 | 32768 | 32768 | 65536 | 65536 | 65536 | 1024 | 256 | 128 |
| 118 | 427-3 | 8192 | 4096 | 65536 | 65536 | 65536 | 256 | 64 | 16 |
| 121 | 378-3 | 4096 | 4096 | 65536 | 32768 | 65536 | 4096 | 1024 | 256 |
| 122 | 16-8 | 16384 | 16384 | 16384 | 32768 | 65536 | 256 | 2048 | 128 |
| 122 | 240-0 | 1024 | 1024 | 4096 | 1024 | 65536 | 256 | 64 | 64 |
| | | | | | | | | | |
| | | | | | | | | | |
| GMT | | 2896 | 4530 | 21247 | 12098 | 28774 | 267 | 91 | 28 |
| L | | 1024 | 1024 | 1024 | 1024 | 4096 | 64 | 16 | 4 |
| H | | 32768 | 32768 | 65536 | 65536 | 65536 | 4096 | 2048 | 256 |
| n. | | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |

**Table 14. Group 3 - Neutralizing Antibody Titers - Coronavirus - Individual Cow Data**

KINSELLA TRIVALENT VACCINE TRIAL 1985-86

GROUP 3 Neutralizing Titres CORONAVIRUS

| | | ← serum → | | | | ← whey → | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Cow # | 18/2 | 21/1 | 4/3 | 26/3 | 1d | 5d | 10d | 20d |
| 97 | 915-3 | 1024 | 4096 | 4096 | 16384 | 65536 | 16384 | 512 | 128 |
| 103 | 466-3 | 65536 | 65536 | 16384 | 65536 | 131072 | 4096 | 64 | 64 |
| 108 | 751-9 | 65536 | 65536 | 16384 | 65536 | 65536 | 4096 | 32 | 64 |
| 109 | 111-9 | 1024 | 1024 | 1024 | 1024 | 16384 | 64 | 16 | 16 |
| 109 | 584-3 | 1024 | 1024 | 1024 | 16384 | 65536 | 256 | 256 | 256 |
| 113 | 786-3 | 16384 | 16384 | 16384 | 16384 | 65536 | 256 | 16 | 16 |
| 115 | 10-2 | 8192 | 1024 | 1024 | 16384 | 16384 | 1024 | 64 | 16 |
| 115 | 281-3 | 4096 | 8192 | 1024 | 16,384 | 16384 | 256 | 64 | 64 |
| 115 | 403-3 | 1024 | 1024 | 1024 | 16384 | 32768 | 64 | 16 | 4 |
| 117 | 428-3 | 1024 | 1024 | 1024 | 16384 | 4096 | 1024 | 256 | 4 |
| 118 | 278-3 | 1024 | 1024 | 256 | 512 | 8192 | 16 | 16 | 4 |
| 120 | 852-3 | 4096 | 4096 | 2048 | 65536 | 65536 | 256 | 32 | 32 |
| 130 | 779-0 | 4096 | 4096 | 4096 | 32768 | 65536 | 256 | 256 | 64 |
| 137 | 447-3 | 8192 | 4096 | 4096 | 65536 | 65536 | 1024 | 256 | 64 |
| 145 | 40-3 | 4096 | 8192 | 8192 | 65536 | 65536 | 1024 | 256 | / |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| — | 380-1 | 1024 | 1024 | 1024 | 4096 | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| GMT | | 3756 | 3756 | 2436 | 16384 | 35941 | 489 | 74 | 29 |
| Range L-H | 1024 | -65536 | 1024-65536 | 256-16,384 | 512-65,536 | 4096-131,072 | 16-16,384 | 16-256 | 4-12 |
| n. | | 16 | 16 | 16 | 16 | 15 | 15 | 15 | 14 |

Table 15. Group 4 - Neutralizing Antibody Titers - Coronavirus - Individual Cow Data

KINSELLA TRIVALENT VACCINE TRIAL 1985-86

GROUP 4 Neutralizing Titres CORONAVIRUS

| | | ← serum → | | | | ← whey → | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Cow # | 18/12 | 21/1 | 4/3 | 26/3 | 1d | 5d | 10d | 20 |
| 98 | 804-3 | 4096 | 1024 | 2048 | 1024 | 8192 | 256 | 4096 | 64 |
| 100 | 437-3 | 4096 | 4096 | 4096 | 4096 | 8192 | 64 | 16 | 64 |
| 104 | 415-3 | 16384 | 16384 | 16384 | 16384 | 65536 | 256 | 64 | 64 |
| 109 | 768-3 | 4096 | 4096 | 4096 | 2048 | 65536 | 64 | 16 | 64 |
| 113 | 701-1 | 1024 | 1024 | 1024 | 1024 | 1024 | 64 | 16 | 4 |
| 114 | 902-3 | 256 | 512 | 256 | 256 | 4096 | 64 | 16 | 4 |
| 115 | 298-3 | 32768 | 8192 | 32768 | 16384 | 65536 | 512 | 256 | 128 |
| 116 | 101-3 | 1024 | 4096 | 2048 | 2048 | 65536 | 64 | 16 | 16 |
| 118 | 448-3 | 1024 | 1024 | 1024 | 1024 | 4096 | 16 | 32 | 4 |
| 124 | 7-9 | 4096 | 4096 | 1024 | 1024 | 16384 | 128 | 64 | 16 |
| 125 | 1-1 | 1024 | 4096 | 4096 | 4096 | 4096 | 128 | 64 | 16 |
| 126 | 3-3 | 2048 | 2048 | 1024 | 1024 | 16384 | 32 | 16 | 4 |
| 146 | 770-7 | 4096 | 2048 | 4096 | 4096 | 16384 | 2048 | 256 | |
| 147 | 469-3 | 2048 | 4096 | 1024 | 2048 | 16384 | 4096 | 1024 | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| — | 235-8 | 16384 | 16384 | 1024 | 16384 | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| GMT | | 2964 | 3104 | 2246 | 2464 | 13 440 | 149 | 67 | 1 |
| Range L-H | | 256 - 32768 | 512 - 16384 | 256 - 32768 | 256 16384 | 1024 - 65536 | 16-4096 | 16-4096 | 4 - 128 |
| n. | | 15 | 15 | 15 | 15 | 14 | 14 | 14 | 12 |